PROJECT DATA

Oxford Performance Materials, Inc. - 03GO13172

Development of Higher Temperature Membrane and Electrode Assembly (MEA) for Proton Exchange Membrane Fuel Cell Device Based on SPEKK Blends

Recipient:	Oxford Performance Materials, Inc.	Instrument Number:	DE-FG36-03GO13172
Recipient Project Director:	Seeverine Valdant 860.698.9300 120 Post Road Enfield, CT 06082	CPS Number:	17832
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Subcontractor(s):	University of Connecticut	B&R Number(s):	ED1906020
		PES Number(s):	03-10157
EERE Program:	Hydrogen, Fuel Cells, and Infrastructure Technologies	State Congressional District:	CT - 2

PROJECT SCOPE: The objective is to operate proton exchange membrane fuel cells (PEMFC) at higher temperatures by developing membrane electrode assemblies (MEAs) based on a novel ion-conducting Sulfonated Poly Ether Ketone Ketone. Increasing the PEMFC operating temperature from 80^{o}C to 120^{o}C could provide significant system integration benefits, including reduced system costs (possibly eliminating $375/kWe out of stationary fuel cell targets of $1500/kWe) and increased system efficiency (potentially increasing from 32 to 40%). The overall objective of these tasks is to demonstrate technical feasibility of MEAs based on Oxford's novel polymer.

FINANCIAL ASSISTANCE

Approved DOE Budget:	$125,000	Approved DOE Share:	$125,000
Obligated DOE Funds:	$125,000	Cost Share:	$94,860
Remaining Obligation:	$0		
Unpaid Balance:	$31,109	**TOTAL PROJECT:**	**$219,860**

Project Period: 9/30/03-9/30/05

TECHNICAL PERFORMANCE
DE-FG36-03GO13172
Oxford Performance Materials, Inc.
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PROJECT SYNOPSIS

The objective of the project is to replace Nafion® in the (MEAs) of Proton Exchange Membrane Fuel Cells (PEMFC) with a higher temperature lower cost blend of a polymer called Sulfonated Poly Ether Ketone Ketone (SPEKK). Oxford Performance Materials (OPM) has an ongoing collaboration with the University of Connecticut (UCONN) and has developed a novel proprietary ion-conductive polymer, SPEKK. SPEKK blends show Nafion®-level conductivity. Proper selection of blend components and control of sulfonation, and nano-structure morphology are critical. SPEKK has outstanding thermal stability (~270°C). Preliminary MEAs, based on SPEKK membranes with Nafion® impregnated catalyst layers, show excellent activity in H_2/air fuel cell tests. The critical task is to eliminate the Nafion®, by developing SPEKK–based catalyst layers.

The use of SPEKK in the catalyst layer is projected to permit performance at desirable higher temperature conditions. Most PEMFC development has used Nafion®-based membranes. However, Nafion® is expensive and poses many well-known limitations. Nafion® has a critical limitation, i.e., increased resistance in higher temperature/lower humidity environments. Several recent scientific reports have identified the benefits of higher temperature membranes concluding they will improve performance, increase efficiency and reduce system costs in PEMFC applications. OPM's invention, if successful, will enable net system efficiency improvements of 6-10% and system cost reductions of $375/kW.

SUMMARY OF TECHNICAL PROGRESS

Work commenced on this project September 19, 2003 with an initiation meeting. The laboratory requirements and necessary equipment and supplies are defined. Equipment needed for testing and production of the test polymers were obtained or fabricated. The setup of testing equipment has begun. The University of Connecticut subcontractor is in the progress of screening and selecting appropriate polymers for testing.

SUMMARY OF PLANNED WORK

OPM plans to complete SPEKK Processing and SPEKK Characterization. OPM also has planned initial MEA testing to show technical feasibility of the SPEKK-based MEA at higher temperatures.

PROJECT ANALYSIS

The project is several months behind. Technical results have yet to become available.

ACTION REQUIRED BY DOE HEADQUARTERS

No action is required from DOE Headquarters at this time.

STATEMENT OF WORK
DE-FG36-03GO13172
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Detailed Task Description

Task 1: SPEKK Material Selection
Two to three optimum SPEKK blends for achieving membrane conductance at higher temperatures will be selected (Target: > 0.1 S/cm at 120^oC, 30% R.H.).

Task 2: SPEKK Blend Processing

Blend processing will include: development of polymer blend processing techniques, evaluating optimum solvent systems and thermal treatments, and preparation of mechanically stable films and catalyst layers. Testing will evaluate solvent cast and/or melt processed blends. The testing target will be: >2000 kPa membrane yield strength and < 15% elongation after exposure to 120^oC, 30% R.H.).

Task 3: SPEKK Blend Characterization
The blend will be characterized for conductance, adhesion and yield strength of optimized films, catalytic layers vs. temperature (25-200^oC), relative humidity, and fractional polymer content. The testing will measure temperature dependence for SPEKK conductivity vs. R.H. and demonstrate catalyst layer adherence.

Task 4: MEA Feasibility

This stage includes demonstrating technical feasibility of SPEKK blend-based MEAs in single cell testing using both H_2/O_2 and H_2 oxidation/reduction reactions and performance of electrochemical cyclic voltametry of Pt in SPEKK MEA environment. The testing will target MEA resistance < 1 ohmcm^2 or < 80 mV resistive polarization at 100 mA/cm^2 on H_2 feed at 120^oC and 30% R.H. and demonstrate mechanically stable MEA interfaces after initial thermal/humidity cycling.

Task 5: MEA Optimization

This task will optimize MEA performance using preferred SPEKK blend and processing steps. This task will prepare a matrix of MEA candidates with various catalyst/SPEKK blend/porosity volumetric ratios (The nominal catalyst will be commercially available 20wt% Pt on Vulcan XC72 carbon.). Identify optimum candidates using single cell testing (Target: MEA resistance < 0.1 ohmcm^2 or <80mV resistive polarization at 1000 mA/cm^2).

Task 6: Platinum (Pt) Loading

OPM will evaluate electrode performance vs. Pt content, preparing a matrix of MEA candidates using optimized MEA preparation techniques as a function of catalyst content (0.1-1 mgPt/cm^2) and catalyst loading (5-40 wt% Pt on carbon). Performance at two Pt loadings will be evaluated vs. a range of temperature (80-200^{o}C) and humidity (10-50% R.H.). Electrochemical utilization of Pt will be measured. (Target: Demonstrate Pt loading < 0.2 mgPt/cm^2 at 120^{o}C).

Task 7: Durability

Selected MEAs will be tested in single cells for 100 hours plotting polarization vs. time. (Target: < 50 μV/hr. decay at 200 mA/cm^2.)

Task 8: Project Management and Reporting

All required quarterly and final reports will be submitted to DOE.

Project Cost Performance in DOE Dollars for Fiscal Year 2003

DE-FG36-03GO13172 **Oxford Performance Materials, Inc.**

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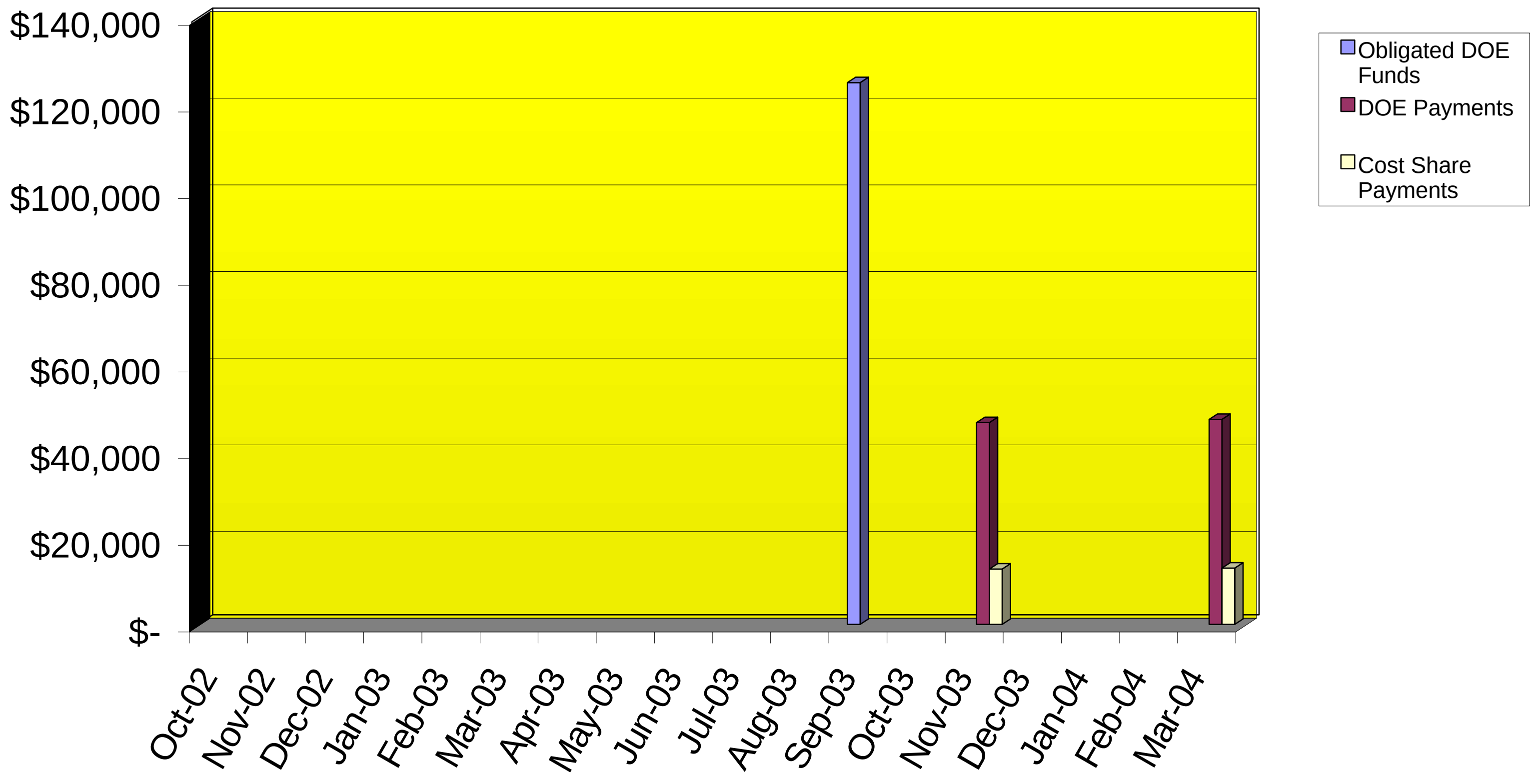

	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$125,000
DOE Payment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cost Share Payment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	PFY*	Cumulative
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$0	$125,000
DOE Payment	$0	$46,563	$0	$0	$0	$47,327	$0	$93,891
Cost Share Payment	$0	$12,810	$0	$0	$0	$13,020	$0	$25,829

Approved DOE Budget:	$125,000
Approved Cost Share Budget:	$94,860
Total Project Budget:	$219,860

* Prior Fiscal Years

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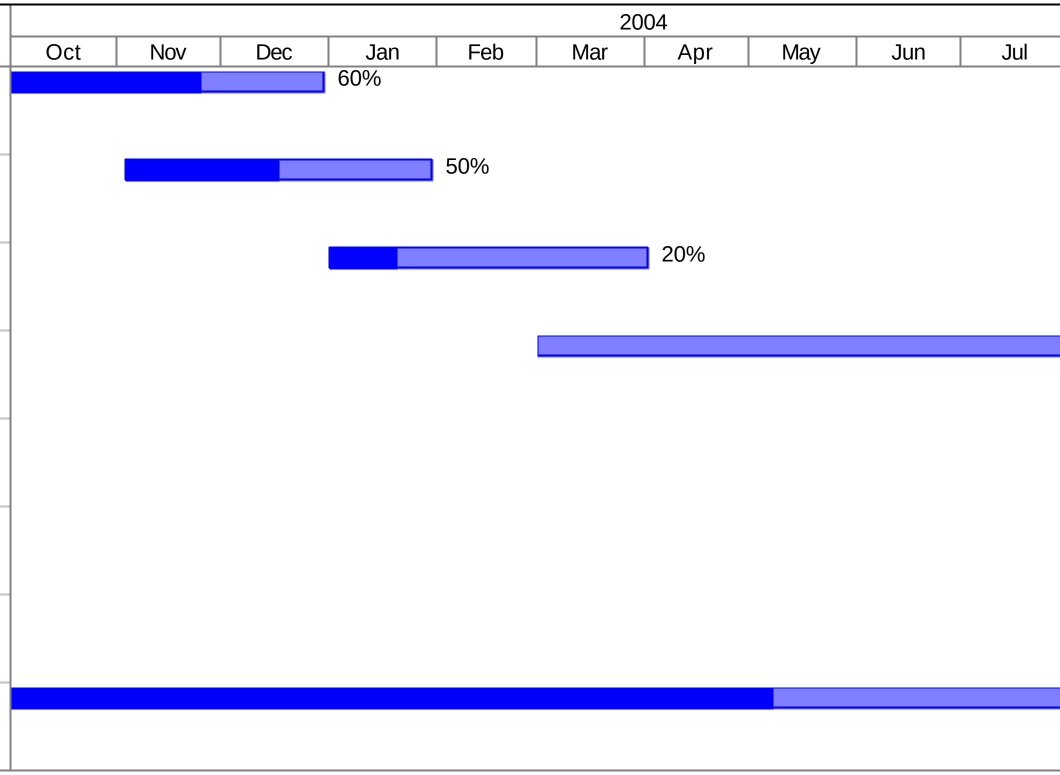
ID	Task Name	Start	Finish
1	Task 1: Material Selection	Wed 10/1/03	Tue 12/30/03
2	Task 2: SPEKK Processing	Mon 11/3/03	Fri 1/30/04
3	Task 3: SPEKK Characterization	Thu 1/1/04	Thu 4/1/04
4	Task 4: MEA Feasibility	Mon 3/1/04	Wed 9/1/04
5	Task 5: MEA Optimization	Mon 8/2/04	Tue 3/1/05
6	Task 6: Pt Loading	Tue 2/1/05	Wed 6/1/05
7	Task 7: Durability	Wed 6/1/05	Fri 9/30/05
8	Task 8: Project Management and Reporting	Wed 10/1/03	Sat 10/1/05



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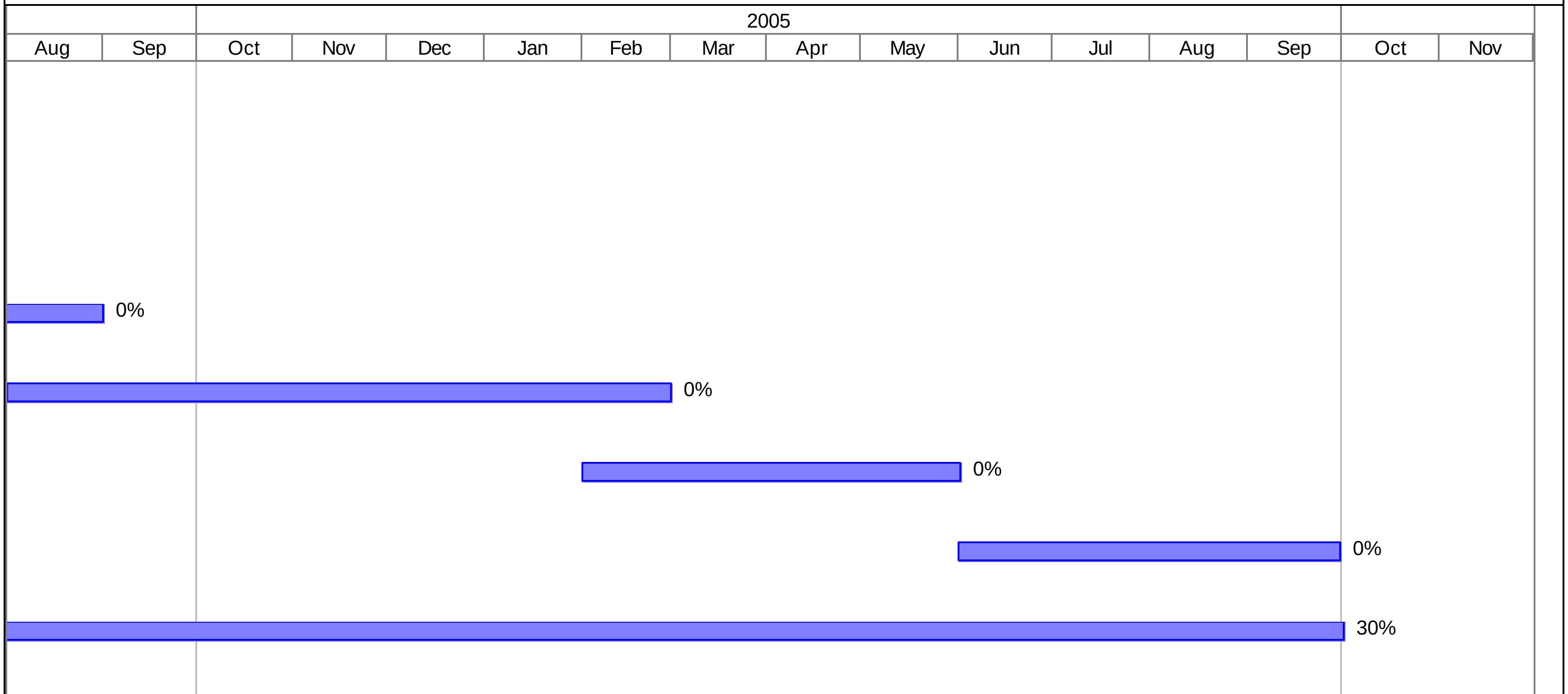

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2006										20					
Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar